

A DATA MINING PROJECT TO IDENTIFY CARDIOVASCULAR RELATED FACTORS THAT MAY CONTRIBUTE TO CHANGES IN VISUAL ACUITY WITHIN THE US ASTRONAUT CORPS

Christian M. Westby¹, Sydney P. Stein², Steven H. Platts³

¹University Space Research Association, Houston, TX, United States

²MEI Technologies, Houston, TX, United States

³NASA, Johnson Space Center, Houston, TX, United States

Many of the cardiovascular-related adaptations that occur in the microgravity environment are due, in part, to a well-characterized cephalad-fluid shift that is evidenced by facial edema and decreased lower limb circumference. It is believed that most of these alterations occur as a compensatory response necessary to maintain a “normal” blood pressure and cardiac output while in space. However, data from both flight and analog research suggest that in some instances these microgravity-induced alterations may contribute to cardiovascular-related pathologies. Most concerning is the potential relation between the vision disturbances experienced by some long duration crewmembers and changes in cerebral blood flow and intra-ocular pressure. The purpose of this project was to identify cardiovascular measures that may potentially distinguish individuals at risk for visual disturbances after long duration space flight. Toward this goal, we constructed a dataset from Medical Operation tilt/stand test evaluations pre- (days L-15-L-5) and immediate post-flight (day R+0) on 20 (3 females, 17 males). We restricted our evaluation to only crewmembers who participated in both shuttle and space station missions. Data analysis was performed using both descriptive and analytical methods (Stata 11.2, College Station, TX) and are presented as means \pm 95% CI. Crewmembers averaged 5207 (3447 – 8934) flight hours across both long (MIR-23 through Expedition16) and short (STS-27 through STS-101) duration missions between 1988 and 2008. The mean age of the crew at the time of their most recent shuttle flight was 41 (34-44) compared to 47 (40-54) years during their time on station. In order to focus our analysis (we did not have codes to separate out subjects by symptomatology), we performed a visual inspection of each cardiovascular measures captured during testing and plotted them against stand time, pre- to post-flight, and between mission duration. It was found that pulse pressure most clearly differentiated the two mission types. Statistical analysis confirmed that pulse pressure was significantly higher before [45.6; (42.1 to 49.1)] and after [50.7; (46.9 to 54.6)] time on station compared with their most recent shuttle flight [31.6 (27.8 to 35.4), and 32.2 (28.3 to 36.0) respectively] even after correcting differences in age and cumulative number of mission hours. Without knowing the identity of which long duration crewmembers demonstrated visual changes, we were limited to examining whether certain crew regulate components of pulse pressure, systolic and diastolic blood pressure, differently due to microgravity exposure. To that end, we stratified crew into tertiles based on either their pre-flight measure of systolic or diastolic blood pressure. Those crew in the highest tertile for both systolic (lower tertile (n=8; 103-111), middle tertile (n=7; 113-121), and upper tertile (n=5; 125-136) and diastolic blood pressure (lower tertile (n=8; 58-64), middle tertile (n=7; 67-73), and upper tertile (n=5; 75-81) demonstrated less variability in pulse pressure between R+0 and L-10 (Figure 2). Interestingly, those crewmembers with the highest resting systolic blood pressure demonstrated either no change or in some instances an increase in total peripheral resistance, where those in the lower tertiles had lower values of total peripheral resistance compared to pre-flight levels. In this study, it was found that crewmembers in the highest tertile for both systolic and diastolic blood pressure demonstrated less variability in pulse pressure and that the decrease in variability was due in part to lower levels of compliance as indicated by similar or higher levels of total peripheral resistance after compared with before flight levels. Whether there is a relation between blood pressure regulation and total peripheral resistance in crew presenting with negative changes in visual acuity remains unknown.